

In Re: Yamamoto, et al.
Application No. 09/600,931
Filing Date: July 21, 2000
Our Docket: 362-43 PCT/US/RCE
Page 2

of the pad trench and the further conductive film formed below the insulating film increasing the effective volume of the conductive film of the pad trench, thereby decreasing the overall electrical resistance of the conductive film of the pad trench.

18. A damascene interconnection as defined by claim 8, wherein the protrusion is formed as a plurality of island protrusions distributed within the pad trench, the plurality of island protrusions reducing the overall volume of the conductive film of the pad trench and increasing the electrical resistance of the conductive film of the pad trench, the further conductive film being formed below the insulating film and the plurality of island protrusions; and wherein the damascene interconnection further includes a plurality of contact holes formed within the pad trench, each contact hole of the plurality of contact holes being positioned near at least one island protrusion of the plurality of island protrusions, each contact hole of the plurality of contact holes being electrically connected between the conductive film of the pad trench and the further conductive film formed below the insulating film to define an electrical connection, the electrical connection between the conductive film of the pad trench and the further conductive film formed below the insulating film increasing the effective volume of the conductive film of the pad trench, thereby decreasing the overall electrical resistance of the conductive film of the pad trench...

REMARKS

The last Office Action in the above-identified application and the references cited by the Examiner have been carefully considered. New Claims 17 and 18 have been added to more specifically and more clearly point out features of Applicants' invention which distinguish over the art of record.

Claims 1-6, 8-13, 15 and 16 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 5,602,423 (Jain) in view of U.S. Patent No. 5,923,088 (Shiue, et al.). The Examiner contends that the Jain patent discloses a damascene interconnection comprising a conductor-filled trench 64 and insulating pillars 50. The

In Re: Yamamoto, et al.
Application No. 09/600,931
Filing Date: July 21, 2000
Our Docket: 362-43 PCT/US/RCE
Page 3

Examiner points to conducting segments 32, 44 and 46 shown in Figure 6 of the Jain patent as lying between insulating pillars 38.

The Examiner acknowledges that the Jain patent does not disclose a contact hole formed within the pad trench to electrically connect the conductive film to a further conductive film formed below the insulating film to substantially suppress an increase in electrical resistance in the pad trench due to the formation of the protrusion (referring to the insulating pillars 50). However, the Examiner contends that the Shiue, et al. patent discloses, in Figure 3, a bond pad structure comprising a third metal pad 30, second via plugs 36 and a second metal pad 32, and that the third metal pad is connected to the second metal pad through the second via plugs. The Examiner concludes that it would have been obvious to one of ordinary skill in the art to include these second via plugs and the second metal pad in the damascene structure disclosed in the Jain patent in order to connect the conducting segments of the damascene structure to a further integration within the substrate.

The rejection of Claims 1-6, 8-13, 15 and 16 in view of the combination of the Jain patent and the Shiue, et al. patent is respectfully traversed. Certainly, via holes and via plugs were well known in the art at the time that Jain invented his damascene structure. Yet, there was no realization on the part of Jain to include a further conductive film positioned underneath the pad trench, as taught by the Applicants herein, and to add contact holes between the upper conductive film of the pad trench and the lower conductive film positioned below the pad trench to electrically conduct the two conductive films to prevent an increase in the electrical resistance of the pad trench, as also taught by the Applicants herein.

Apparently, Jain never appreciated that his pillars 50 will affect (increase) the electrical resistance of his landing pad 55 and have a deleterious effect on the electrical conductivity of the semiconductor structure. Applicants herein did realize this and, accordingly, added the lower conductive film positioned below the pad trench and contact holes to electrically connect the upper conductive film with the lower conductive film, to offset (decrease) any increase in the electrical resistance of the upper conductive film of the pad trench due to the protrusions.

In Re: Yamamoto, et al.
Application No. 09/600,931
Filing Date: July 21, 2000
Our Docket: 362-43 PCT/US/RCE
Page 4

As shown in Figure 13 of the Jain patent, no lower conductive film is formed below the pillars 50, such lower conductive film being taught by the Applicants herein. As shown in Figures 5 and 6 of the Jain patent, no lower conducting film to decrease the resistance of an upper conducting film of the landing pad 55 is shown below pillars 38 or conducting segments 32, 44 and 46. Jain knew about vias, because he included one in his structure shown in Figure 13 (at 58). But he did not think to include a lower conducting film interconnected by vias to an upper conducting film of his landing pad to counter the effect that his pillars might have in increasing the electrical resistance of his landing pad 55. The Applicants herein realized the problem and solved it by the particular structure set forth in independent Claims 1 and 8 and in dependent Claims 2-6, 9-13 and 15-18.

The Shiue, et al. patent merely discloses vias or via plugs. Just like Jain, Shiue, et al. never addressed the problem of the increased electrical resistivity of a pillared landing pad; the patent does not even disclose a damascene interconnection. The purpose of the bond pad structure of the Shiue, et al. patent is to increase the tensile strength and shear strength of the bond pad structure, by including two layers of via plugs formed between three metal layers. Increased resistivity of a pillared landing pad was never considered by Shiue, et al., just like it was never considered by Jain.

Applicants acknowledge and appreciate the Examiner's citation of the Shiue, et al. patent as only for showing that interconnections can be made from a metal pad to a lower metal pad. Nevertheless, Applicants cannot see the motivation for combining the two references where none of the prior art patentees realized the problem of, or found the solution to, the increased electrical resistivity of a pillared landing pad. Only Applicants solved this problem, and in a particular manner and with the particular structure set forth in the claims herein. It is respectfully urged that there is no teaching or suggestion in either reference to combine one with the other, because each of the Jain patent and the Shiue, et al. patent addresses different problems. With respect to the limitation "substantially suppress an increase in electrical resistance in said pad trench due to formation of said protrusion", in Claims 1 and 8, such language should be considered and given patentable weight and does, indeed, limit the structure of the damascene interconnection defined by independent Claims 1

In Re: Yamamoto, et al.
Application No. 09/600,931
Filing Date: July 21, 2000
Our Docket: 362-43 PCT/US/RCE
Page 5

and 8. Clearly, as defined by these claims, the electrical resistance of the pad trench is maintained at an acceptable level by the interconnection of the conductive film in the pad trench between the protrusions and the further conductive film formed below the insulating film. The electrical resistance, a structural limitation, of the pad trench which increased due to the protrusion causing the open area of the pad trench to decrease, a further structural limitation, is lowered by including the conductive film formed below the insulating film and connecting that conductive film to the conductive film of the pad trench, as specifically defined by Claims 1 and 8.

Accordingly, it is respectfully urged that independent Claims 1 and 8 define patentable subject matter which differs from the semiconductor structure and the purpose for that structure disclosed in the Jain patent and the Shiue, et al. patent, taken alone or in combination, and, accordingly, it is respectfully urged that Claims 1 and 8 are allowable.

Claims 2-6, 9-13, 15 and 16 depend directly or indirectly from independent Claims 1 and 8. As such, they are respectfully urged to patentably distinguish over the references of records for the same reasons submitted with respect to Claims 1 and 8.

New Claims 17 and 18 have been added for the Examiner's consideration. Claims 17 and 18 depend directly from Claims 1 and 8, respectively. Each of new Claims 17 and 18 is submitted herewith in a sincere effort to define the resistance of the pad trench in structural, as opposed to functional, terms. Also, the protrusion is defined as being in the form of a plurality of island protrusions distributed over the pad trench, and the damascene interconnection is further more specifically defined in these claims as including a plurality of contact holes, where each contact hole is positioned near at least one of the island protrusions. Additionally, the further conductive film is specifically defined as being formed below the plurality of island protrusions, and the contact holes are specifically defined as being electrically connected between and to the conductive film of the pad trench and the further conductive film formed below the plurality of island protrusions.

Clearly, neither the Jain patent nor the Shiue, et al. patent discloses the specific structure set forth in new Claims 17 and 18. No lower conductive film is disclosed in the Jain

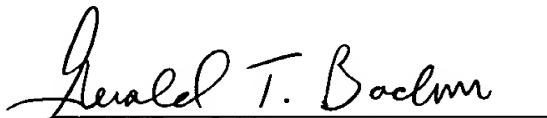
In Re: Yamamoto, et al.
Application No. 09/600,931
Filing Date: July 21, 2000
Our Docket: 362-43 PCT/US/RCE
Page 6

patent. Also, the via 58 is not positioned near one of a plurality of island protrusions (for example, protrusion 50 shown in Figure 13) in the Jain patent. Electrical resistivity of the landing pad 55, or the effects thereon due to protrusions 50, is not disclosed in the Jain patent.

The Shiue, et al. patent does not teach or suggest the particular structure set forth in new Claims 17 and 18 submitted for the Examiner's consideration. Again, electrical resistance of the three metal layers, or the effects thereon by any structure even remotely comparable to a protrusion in the metal layers, is not disclosed or discussed in the Shiue, et al. patent. Neither protrusions nor specifically positioned contact holes (positioned near each protrusion) are disclosed or discussed in the Shiue, et al. patent. Accordingly, it is respectfully urged that new Claims 17 and 18, added in a sincere effort to overcome the Examiner's rejection of the pending claims, patentably distinguish over the references of record and are allowable.

In view of the foregoing remarks and submission of new Claims 17 and 18, favorable reconsideration of Claims 1-6, 8-13, 15 and 16, favorable consideration of new Claims 17 and 18, and allowance of the application with Claims 1-6, 8-13 and 15-18 are respectfully solicited. If the Examiner has any suggestions or comments which would be helpful to advance this application to a favorable conclusion, such would be appreciated by the undersigned attorney, and the undersigned attorney may be reached at the telephone number given below.

Respectfully submitted,



Gerald T. Bodner
Registration No. 30,449
Attorney for Applicants

BODNER & O'ROURKE, LLP
425 Broadhollow Road, Suite 108
Melville, New York 11747
Telephone: (631) 249-7500
Facsimile: (631) 249-4508